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February 4, 2000

VIA EXPRESS MAIL LABEL NO. EL527471700US
BOX PATENT APPLICATION
Honorable Commissioner of Patents
 and Trademarks
Washington, D.C. 20231

> RE: U.S. Patent Application
> Inventor: Alex Krister Raith
> **SYSTEM AND METHOD FOR IMPROVING CHANNEL**
> **MONITORING IN A CELLULAR SYSTEM**

Dear Sir:

Enclosed please find the above-identified U.S. Patent Application, which includes the following:

1. Specification and Claims
2. Formal Drawings (3 sets of 6 sheets)
3. Declaration and Power of Attorney for Patent Application
4. Assignment including Recordation Form Cover Sheet
5. **Express Mail Certification - Label No. EL527471700US**
6. Postcard

Also enclosed please find our check in the amount of **$1486.00** to cover the Government Filing Fee and recordation of the Assignment. If fees are not sufficient, please deduct from our Deposit Account No. 18-1167.

Respectfully submitted,

COATS & BENNETT, P.L.L.C.

By: John R. Owen

John R. Owen
Registration No. 42,055

JRO/mjp
Enclosures
P-4015.398

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:)
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Alex Krister Raith)
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Serial No._____)
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Filed:_____)
)
For: SYSTEM AND METHOD FOR)
       IMPROVING CHANNEL MONITORING)
       IN A CELLULAR SYSTEM)
)
Attorney's Docket No. P-4015.398)

**Express Mail Certification
Label No.EL527471700US**

Raleigh, North Carolina

February 4, 2000

Honorable Commissioner of Patents and Trademarks
BOX PATENT APPLICATION
Washington, D.C. 20231

Sir:

EXPRESS MAIL CERTIFICATE LABEL NO. EL527471700US
DATE MAILED: February 4, 2000

I hereby certify that the enclosed specification and claims, drawings (3 sets of 6 sheets), Declaration and Power Of Attorney, Assignment and Recordation Sheet, and our Check # 0814 in the amount of $1,486.00, are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. §1.10 on the date indicated above and is addressed to Honorable Commissioner of Patents and Trademarks, BOX PATENT APPLICATION, Washington, D.C. 20231.

Respectfully submitted,

COATS & BENNETT, P.L.L.C.

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UNITED STATES PATENT APPLICATION FOR GRANT OF LETTERS PATENT

Alex Krister Raith
INVENTOR

SYSTEM AND METHOD FOR IMPROVING CHANNEL MONITORING IN A CELLULAR SYSTEM

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1 # SYSTEM AND METHOD FOR IMPROVING CHANNEL MONITORING IN A
2 # CELLULAR SYSTEM
3
4 ## BACKGROUND OF THE INVENTION

5 The present invention relates generally to the management of mobile stations in a

6 wireless communication system and, more particularly, to a system and method for

7 providing improved channel selection procedures.

8 In a wireless communication system, the service area is typically divided into a

9 plurality of cells, with each cell served by a base station. Mobile stations within a

10 particular cell communicate over RF channels with the base station serving that cell. The

11 base station may handle a plurality of simultaneous calls from mobile stations. The base

12 stations are connected with one another and to the public switched telephone network by

13 mobile services switching centers (MSC). The MSC coordinates the activities of all the

14 associated base stations and connects the entire cellular system to the public switched

15 telephone network. A typical MSC may handle 100,000 cellular subscribers and 5,000

16 simultaneous conversations at a time. The MSC also accommodates billing and system

17 maintenance functions. In some higher density networks, several MSCs are used in a

18 single network.

19 During the course of a call, the mobile station may move from one cell into

20 another. A switching technique called a handoff enables the call to proceed uninterrupted

21 when the user moves between cells. When the mobile station moves into a different cell

22 while a call is in progress, the MSC automatically transfers the call from the current

23 channel being used to a new channel belonging to the base station serving the new cell.

24 Processing handoffs is an important task in any wireless communication system.

25 Handoffs ensure that acceptable signal quality standards are maintained as the mobile

1 station moves out of range of one base station and into the radio coverage area of another

2 base station. Handoffs should be performed successfully and be imperceptible to the

3 user. Also, because of the signaling demand a handoff places on the system, handoffs

4 should be performed as infrequently as possible and only as needed.

5   Handoff decisions are typically based on received radio signal strength and

6 channel quality as monitored by the base station serving the mobile station. Received

7 signal strengths are easily monitored and signal quality for any given channel is often

8 determined by the bit error rate (BER) over a given channel. During any communication

9 period, the cellular system will continually seek a better channel and cell for

10 communications. A handoff from the current channel to another channel is initiated

11 when the signal level or channel quality drops below acceptable levels and another

12 channel is available capable of providing acceptable communications.

13   In digital systems, such as Global System for Mobile communications (GSM) and

14 Time Division Multiple Access (TDMA) systems, the base stations enlist the assistance

15 of the mobile station to determine when a handoff is required. In order to use a mobile

16 station to assist handoff, the serving base station downloads a list of channels, commonly

17 referred to as a neighbor list, at the start of a call or after a handoff. The neighbor list

18 identifies channels in neighboring cells which are potential handover targets. In a mobile

19 assisted handoff (MAHO), each mobile station measures the received power from

20 surrounding base stations provided by the neighbor list, which is also referred to as a

21 MAHO list. The mobile station continually reports the results of these measurements to

22 the serving base station. These reports are often referred to as MAHO reports. The

23 signal strength measurements are made by the mobile station in between periods of

1   communication during a call. For example, in GSM systems, each radio frequency

2   channel is divided into eight time slots. In TDMA systems, each radio frequency channel

3   is divided into six slots. The mobile station is allocated one time slot for transmissions

4   and another time slot to receive signals from the base station. During the remaining time

5   slots, the mobile station is not communicating with the serving base station. The mobile

6   station monitors channels belonging to neighboring base stations during these idle

7   periods and then quickly returns to its assigned channels in time to transmit and receive

8   signals in its allocated time slot. The measurements made by the mobile station of

9   signals received from neighboring cells are reported back to the serving base station in a

10   scheduled manner or on a separate channel so as not to interfere with voice or data

11   transmissions. During multi-slot operation, the time slots normally used for

12   communications are "borrowed" to allow the mobile station to report measurements to

13   the base station. This concept is typically referred to as frame stealing and reduces

14   transmission rates.

15   The measurement reports provided by the mobile station give the base station a

16   list of the signal strength and possibly channel quality from adjacent cells, as measured

17   by the mobile station at its present location. The network also knows which adjacent

18   cells have unused radio channels that are available for allocation during a handoff. From

19   the list of available channels, the network selects the cell which best will handle the call

20   from a service quality and an overall interference point of view based on signal strength

21   and bit error rate. A suitable traffic channel is assigned that cell as the target, and the

22   mobile station is commanded to return to the traffic channel in the target cell. At the

23   same time, the call is switched by the MSC to the base station currently serving the

3

1 mobile station to the base station in the target cell. The mobile station switches to the

2 newly assigned channel during one of the idle periods so there is no interruption in

3 transmission. Thus, from the user's perspective, the handover is seamless.

4 Cell reselection is the process of changing channels for service and registering

5 with a new base station when the mobile station is not active. When the mobile station is

6 between calls and not actively communicating with a base station, but is ready to receive

7 or place calls, it monitors one or more control channels of proximate base stations to

8 receive paging or other instructions. This state of operation is commonly referred to as

9 the idle state or idle mode. Since there is no two-way communication in place while in

10 idle mode, the cellular system does not know which base station the mobile station

11 should monitor. Typically, the mobile station monitors signal strength along with other

12 indicia indicative of channel quality in order to select a base station. In older analog

13 systems, the selected base station was typically the one providing the strongest signal. In

14 modern digital systems supporting hierarchical cell structures, the mobile station

15 performs a much more elaborate evaluation of candidate cells.

16 As the mobile station moves throughout areas of coverage for various base

17 stations, it acquires information about channels and their attributes used or associated

18 with surrounding base stations by reading a list of channels sent on a broadcast channel

19 for each cell from which it is able to receive information. This list is also commonly

20 referred to as a neighbor list. The neighbor list identifies specific channels for the mobile

21 station to monitor when idle. In essence, the mobile station monitors the listed channels

22 and decides on the best channel for service. When the mobile station decides a new

1 channel is required, it may send information to the new base station to register and effect

2 cell reselection.

3   While idle, mobile stations make a tradeoff between accurate neighbor list

4 measurements and energy consumption. U.S. patent number 5,539,748 entitled

5 Enhanced Sleep Mode in Radio Communication Systems discloses a few basic

6 techniques to reduce the neighbor list measurements without sacrificing the quality of

7 these measurements. In essence, the patent describes a very basic system-assisted and a

8 mobile station-controlled method for reducing the number of neighbor list measurements.

9 In the former, the cellular system sends the mobile station the minimum, nominal

10 frequency and measurement for each entry in the neighbor list. The cellular system

11 provides an indication that certain entries can be measured with a reduced frequency.

12 This is applicable if there are many entries in the neighbor list or the entries are in a

13 hierarchical cell layout. In the latter, the mobile allows a reduced measurement

14 frequency from the nominal requirement if no cell reselection has been performed for a

15 specified time. Alternatively, the measurement is reduced if changes of signal strength

16 for the serving control channel and neighbor list entries are less than specified.

17   A significant amount of system resources and power are used while assisting a

18 base station during handoffs and monitoring nearby stations for cell reselection. Given

19 the premiums placed on getting the most use of allocated bandwidth and extending

20 battery life, there is a need for an improved channel selection system and method to

21 reduce processing time and energy consumption associated with channel selection during

22 active and idle modes without degrading performance.

23

SUMMARY OF THE INVENTION

In recent years, the cost of manufacturing a global positioning system (GPS)
receiver has been reduced to a level that makes it practical to incorporate GPS receivers
into consumer electronics. A mobile station equipped with a GPS receiver or similar
position determining electronics could provide accurate position information to the
mobile station and associated network to assist the network in system management
functions, and in particular, assist with channel selection.

The present invention relates to a mobile station capable of determining its current
location within a wireless communication system. The mobile station periodically
generates an estimate of its current location or mobility and then monitors channels for
channel selection based thereon in order to minimize frame stealing while in active mode
and save energy during idle mode. The same information is also useful for determining
which cells to monitor and controlling how frequently position or changes of position
estimates are made. Although the invention requires a determination of the mobile
station's position or mobility, the manner in which the mobile station determines these
characteristics may vary. A separate positioning receiver, which receives signals from a
terrestrial or satellite station, may allow the mobile station to calculate its position.
Alternatively, the mobile station may monitor signals provided during communications
with the base stations to calculate a relative position. In yet another embodiment, the
base stations and associated cellular systems may cooperate to determine a particular
mobile station's position and then download the position to the mobile station. Those
skilled in the art will recognize numerous techniques for identifying a mobile station's
position or mobility and use that information according to the teachings of the present

1   invention. Existing and future position and mobility determining means are considered

2   within the scope of the invention.

3   Accordingly, each cell in the neighbor or MAHO list may be measured with an

4   independent measurement frequency varying from a nominal default to zero. The

5   cellular system may assist the mobile station with position-related attributes to the entries

6   on the neighbor and MAHO list, such as the position of neighboring cells and the position

7   of the base station's transmitter for that cell. This information, although not limited to, is

8   preferably transmitted on the broadcast channel in a neighbor list or a point-to-point

9   channel in a MAHO list message.

10   These and other aspects of the present invention will become apparent to those

11   skilled in the art after a reading of the following description of the preferred embodiment

12   when considered with the drawings.

13

14   BRIEF DESCRIPTION OF THE DRAWINGS

15   Figure 1 is a schematic representation of a cellular network.

16   Figure 2A is a block diagram of a telephone embodiment of a mobile terminal

17   with a positioning receiver.

18   Figure 2B is a block diagram of an alternative embodiment of a mobile terminal.

19   Figure 3 is a representation of cellular layout having omni-directional cells with

20   distinct areas defined therein.

21   Figure 4 is a representation of cellular layout having sectorized cells with distinct

22   areas defined therein.

1   Figure 5 is a flow chart outlining the basic process for improving channel

2   selection and monitoring during active and idle modes.

3

4   DETAILED DESCRIPTION OF THE INVENTION

5   In the following description, like reference characters designate like or

6   corresponding parts throughout the several views. Referring now to the drawings, the

7   improved channel selection method of the present invention is described. Channel

8   selection according to the present invention is useful in mobile cellular systems like that

9   shown schematically in Figure 1. The mobile cellular system, which is indicated

10   generally by the numeral 10, includes a plurality of base stations 12, which are connected

11   via a mobile services switching center (MSC) 14 to a terrestrial communications network

12   such as the Public Switched Telephone Network (PSTN) 18. Each base station 12 is

13   located in and provides service to a geographic region referred to as a cell. In general,

14   there is one base station 12 for each cell within a given system. Within each cell, there

15   may be a plurality of mobile stations 16 that communicate via a radio link with the base

16   station 12. The base station 12 allows the user of the mobile station 16 to communicate

17   with other mobile stations 16, or with users connected to the PSTN 18. The mobile

18   services switching center 14 routes calls to and from the mobile station 16 through the

19   appropriate base station 12. Information concerning the location and activity status of the

20   mobile station 16 is stored in a Home Location Register (HLR) 20 and a Visitor Location

21   Register (VLR) 22, which are connected to the MSC 14.

22   It is worth noting that a different architecture is often used for packet data

23   sessions, such as that used in GPRS and Mobile IP. As such, there may be no

8

1   involvement from the MSC 14. In essence, the base station 12 is connected to a packet

2   data node, and then to the public packet data network through additional nodes to reach

3   the internet. Furthermore, the concepts of the present invention are applicable to all

4   current and future wireless communication systems, including cdma2000 and WCDMA.

5   Figure 2A is a block diagram of a mobile station 16 adapted to receive position

6   indicia. In particular, the disclosed embodiment of the mobile station 16 is a fully

7   functional cellular telephone, such as an IS95 compliant cellular telephone, capable of

8   transmitting and receiving signals. The cellular telephone 16 includes a control unit 22,

9   which is typically a microcontroller-based system for controlling the operation of the

10   cellular telephone 16, and a memory 24 for storing control programs and data used by the

11   cellular telephone 16 during operation. Input/output circuits 26 interface the

12   microprocessor 22 with a keypad 28, a display 30, audio processing circuits 32, receiver

13   38, transmitter 40, and positioning receiver 50. The keypad 28 allows the operator to dial

14   numbers, enter commands, and select options. The display 30 allows the operator to see

15   dialed digits, stored information, and call status information. The audio processing

16   circuits 32 provide basic analog audio outputs to a speaker 34 and accept analog audio

17   inputs from a microphone 36. The receiver 38 and transmitter 40 receive and transmit

18   signals using a shared antenna 44. The positioning receiver 50, which may for example

19   be a Global Positioning System (GPS) receiver, enables the mobile station 16 to

20   determine its current location based on positioning signals transmitted by a GPS satellite.

21   The receiver 50 requires an antenna, which may be separate from or integrated with the

22   mobile station's antenna. The positioning receiver 50 could also be designed to receive

23   similar positioning signals from terrestrial sources.

1   Alternatively, the mobile station 16 may be configured to determine a relative

2   position or mobility based on signals received from one or more base stations 12. For

3   example, the cellular system may determine the mobile station's position or mobility

4   using triangulation or similar positioning techniques and then download the mobile

5   station's position to the mobile station 16. Alternatively, the mobile station 16 may use

6   its communication and control electronics to monitor signals received from one or more

7   base stations and calculate its relative position or mobility, also using triangulation or like

8   techniques. Such a system is shown in figure 2B without a separate receiver for

9   positioning estimating.

10   The mobile station 16 is programmed to periodically monitor selected control

11   channels in adjacent cells and to perform channel quality measurements on those

12   channels. Channel quality measurements may include received signal strength, bit error

13   rate (BER), and word error rate (WER), as well as other parameters. Channel quality

14   measurements may, for example, be transmitted by the mobile station 16 to the base

15   station 12 to assist the base station 12 in making hand-off determinations. Hand-offs

16   made by the base station 12 on the basis of channel quality measurements made by the

17   mobile station 16 are known as mobile assisted hand-offs. Channel quality

18   measurements may also be used by the mobile station for cell reselection. Cell

19   reselection may occur, for example, when the mobile station 16 is in a idle mode or

20   engaged in a packet data session.

21   According to the present invention, the mobile station 16 is programmed vary the

22   frequency at which channel quality measurements are made based on the position of the

23   mobile station 16, or some function of that position. For example, the mobile station 16

1   may be programmed to determine its position relative to the currently serving base station

2   12 and vary the frequency of the channel quality measurements as a function of the

3   distance from the serving base station 12. In this case, the frequency of channel quality

4   measurements would increase as the distance from the serving base station increased. In

5   another embodiment, the mobile station 16 may determine its position relative to the

6   serving base station 12 and a target base station 12 in a neighboring cell and vary the

7   frequency of measurement as a function of the distance from both base stations 12. In

8   this case, the frequency of reporting may be dependent on the ratio of the distances

9   between the serving base station and the target base station 12. Another embodiment

10   would be to monitor the position of the base station 12 and vary the frequency of channel

11   quality measurements based on the mobility of the mobile station 16. For purposes of

12   this application, the term mobility is defined to be any function of position and time, such

13   as the rate of change in position of the mobile station 16 over time. Another example of

14   mobility would be the amount of time the mobile station 16 stays in one position. In this

15   case, the frequency of channel quality measurements would increase with increasing

16   mobility.

17   While the disclosed embodiment relates to the performance of channel quality

18   measurements by the mobile station, those skilled in the art will recognize that the

19   present invention could be adapted for other channel monitoring functions, or any other

20   periodic tasks that need to be performed by the mobile station. Also, those skilled in the

21   art will recognize that the frequency of the channel monitoring functions could also be

22   dependent on other factors, in addition to position or mobility.

23

1   By adjusting the frequency of reporting in an intelligent manner, it is possible to

2   minimize the amount of frame stealing required during active mode and reduce

3   monitoring activities during idle mode to conserve energy. Importantly, the measurement

4   procedures according to the present invention avoid or minimize any impact on the

5   quality of handoff or cell reselection procedures. In essence, handoffs and cell

6   reselection should take place at about the same time and to the same cell as that provided

7   by existing channel selection procedures. The primary difference is reduced frame

8   stealing and decreased energy consumption.

9   To implement the present invention, the mobile station 16 must estimate its

10   position periodically. The need to estimate position may potentially conflict with the

11   objective of saving battery life while in idle mode. However, there may be other

12   applications that dictate the need for position estimates, such as for acquiring a position

13   used in emergency calling. Furthermore, the frequency of making position estimates may

14   be one or more magnitude less than channel selection measurements. If no mobility is

15   detected and hence, very infrequent neighbor list measurements and position estimates

16   are made, there is a net gain in battery life. During active mode, the object is to minimize

17   required frame stealing and not the frequency of measurement per se. Hence, during

18   active mode, the battery drain due to performing position estimates is a secondary issue.

19   The basic process for improving channel selection and monitoring during active

20   and idle modes is outlined immediately below in association with the flow chart of Figure

21   5. The process begins (block 100) when a call is initiated or a handoff occurs (block

22   102). A mobile station 16 (MS) receives a neighbor list or MAHO list (block 104)

23   outlining channels associated with surrounding cells, which are to be monitored by the

1   mobile station 16. At any point during this process, the mobile station 16 periodically

2   determines its estimated position and/or mobility (block 106). Notably, position or

3   mobility determinations need not occur at the channel monitoring frequency or a

4   frequency dependent on how often the mobile station 16 monitors channels from the

5   neighbor or MAHO list. Also, it should be noted that position estimating is a periodic

6   function and that the frequency at which the position of the mobile station 16 is updated

7   could also vary in accordance with the present invention. Thus, the mobile station 16

8   could be programmed to perform additional calculations to update the frequency of

9   position estimating after updating its current position, or to determine a time at which to

10   update its current position.

11   While the mobile station 16 is actively handling a call, it monitors the channels on

12   the MAHO list at a frequency depending on the mobile station's position or mobility

13   (block 108). Preferably, the position or mobility determinations also bear on which

14   channels to monitor, and possibly, which to avoid. Notably, the frequency at which the

15   mobile station 16 monitors these channels may also be influenced by other factors, such

16   as the current state of the call, the type of call, etc. Further details regarding these factors

17   are outlined below. During this time, the mobile station 16 also monitors signals from

18   the base station serving the mobile station 16 for handoff instructions (block 110).

19   Assuming the call continues, the mobile station 16 will determine whether or not to

20   change channels based on the handoff information from the base station, or in certain

21   proposed systems such as DECT, the mobile station 16 may make the determination

22   independently and signal the cellular system accordingly (block 114). As noted above, in

1   most digital systems, the handoff decision is made by the serving base station with the

2   assistance of the mobile station 16.

3   If a handoff (block 114) is not required, the mobile station 16 repeats the process

4   of determining its position or mobility and continues monitoring the channels on the

5   neighbor or MAHO list based thereon. If a handoff is required, the system typically

6   downloads a new MAHO list and repeats the above processes accordingly.

7   When a call ends (block 112), the mobile station 16 typically changes from an

8   active mode of operation to an idle mode. During idle mode, the mobile station 16 is still

9   served by a base station in the sense that it selects a base station for registration purposes

10   and transmits signals to the serving base station to effect such registration. When idle,

11   the mobile station 16 typically determines when cell reselection is necessary and effects

12   new registration any time channels or cells are changed.

13   Assuming a call is not received or the mobile station 16 is not required to set up a

14   new call (block 116), the mobile station 16 downloads neighbor lists from the serving

15   base station, and perhaps, lists from other base stations providing signals of sufficient

16   strength and quality (block 120). During this process, the mobile station 16 periodically

17   determines its position or mobility (block 122). Based on this determination, the mobile

18   station 16 monitors the channels from the neighbor list with a frequency depending

19   position or mobility (block 124). As discussed further below, the mobile station 16 may

20   receive access to information bearing on the position of the serving and surrounding base

21   stations as well as coordinates defining areas served by select channels within a cell.

22   Given certain or all of this information, the mobile station 16 may control the frequency

23   of measurements and the channels to measure based on its relative position to a single

1   base station, relative position between two base station, or its relative position within a

2   defined area or cell.

3   When mobility is a variable controlling these measurements, the mobile station 16

4   may base these measurements on mobility alone, relative to a single base station 12,

5   relative to multiple base stations 12, or combine a mobility determination with relative

6   position to one or more areas or cells. The frequency at which these channels are

7   monitored or which channels are monitored are also subject to influence by other factors,

8   such as signal strength, signal quality, etc. The mobile station 16 then determines

9   whether or not to change serving cell for cell reselection based on the monitoring of the

10 channels on the neighbor list and the serving base station (block 126). If cell reselection

11 occurs, the mobile station 16 may be required to register with the cellular system in order

12 to identify itspresence in the new paging area if necessary. The process will repeat until a

13 new call is arranged or the phone is completely powered down.

14   The mobile station 16 communicates with the base station 12 using a

15 communications channel. The term channel can have various meanings depending on the

16 context. In general, an RF channel refers to a single allocation of a contiguous spectrum.

17 In the AMPS and IS-136 systems, an RF channel is a 30 kHz allocation in the 850 MHz

18 band or the 1900 MHz band. In GSM, an RF channel is a 200 kHz in the 900 or 1950

19 MHz bands and 1800 MHz for GSM. The term channel may also refer to an information

20 channel (control channel or traffic channel) in a TDMA or CDMA system. In a TDMA

21 system, an information channel comprises one or more time slots on an RF channel that

22 are allocated to a mobile station 16 for transmitting and receiving. In a CDMA system,

23 an information channel is distinguished by an unique coding scheme that further

1 subdivides the RF channel. For purposes of this application, the term communications

2 channel or channel will generally refer to an information channel, which could be the

3 same as an RF channel in some systems.

4   There are essentially two types of cellular communication techniques, circuit-

5 switched and packet-switched. A circuit-switched connection is a circuit connection that

6 is established and maintained, usually on demand, between two or more stations to allow

7 the exclusive use of the circuit until the connection is released. A packet-switched

8 connection is a logical connection that is established between two or more stations to

9 allow the routing and transfer of data in the form of packets. The channel is occupied

10 during the transmission of a packet only. Upon completion of the transmission, the

11 channel is made available for the transmission of other packets for the same or other

12 stations. Channel selection procedures typically vary depending on whether circuit-

13 switched or packet-switched connections are used.

14   For circuit-switched data communications, mobile-assisted handoffs are typically

15 used where the mobile assists with measurements and the cellular system controls

16 channel allocation. Since the mobile station 16 is continuously allocated an uplink

17 channel, as for a voice call, measurement reports are typically sent on a call-associated

18 control channel. In contrast, during a packet data session, the mobile station 16 does not

19 transmit for extensive periods. During these packet sessions, sending a mobile-assisted

20 handoff report would unnecessarily use uplink channels shared by multiple mobile

21 stations 16. Thus, packet data protocols typically specify that the mobile station 16 finds

22 the best channel and the cellular system relinquishes control in order to save bandwidth.

1   The process of allocating the mobile station 16 to the best base station 12 during

2 an active packet data session is similar or identical to the cell reselection process while in

3 idle mode. A neighbor list is received from the cellular system and the mobile system

4 measures and evaluates the candidate cells based on channel quality. In order to maintain

5 conciseness and readability, the terms neighbor list and MAHO list are used to refer to

6 any type of measurement list identifying channels or base stations to monitor. These

7 terms are used to facilitate an understanding of the invention by associating a neighbor

8 list with idle operation and packet data operation and a MAHO list for active operation.

9 However, these therms are interchangeable and each may be used to describe

10 measurement lists for active and idle modes. As such the disclosure and claims should be

11 interpreted accordingly. Nothing prevents a hybrid solution in which the mobile station

12 16 performs cell reselection measurement and selection and the cellular system overrides

13 the default cell reselection process by sending a handoff command. Notably, the GPRS

14 packet data protocols in GSM systems support mobile station 16 and network-initiated

15 cell reselection.

16   There are implications for letting the mobile station 16 evaluate neighboring cells.

17 The particular implication depends on whether the mobile station 16 is operating in active

18 or idle mode. For TDMA systems operating in active mode, the number of time slots per

19 TDMA frame is large enough such that there is ample amount of time for the mobile

20 station 16, during non-assigned time slots, to perform neighbor list (or MAHO list)

21 measurements. However, for multi-slot operation, such as when all slots are allocated,

22 there is no spare time for neighbor list or MAHO list measurements. During idle mode,

23 availability of time slots is not an issue. The primary objective for the mobile station 16

17

1   is to minimize current consumption while successfully monitoring the assigned

2   communication channel and performing neighbor list measurements.

3   Numerous techniques exist for minimizing the impact of these constraints. For

4   example, when mobile station 16 is operating in active mode and a time is available for

5   MAHO list measurements, either a second receiver is used to assist in communications or

6   the mobile station 16 stops transmitting or receiving data on one or more slots and uses

7   the slots to perform the list measurement. The latter is referred to as frame stealing,

8   which inherently reduces communication throughput.

9   Communication protocols include retransmission of lost data, but this reduces the

10   efficiency of the system. The tradeoff is typically loss of throughput versus measurement

11   accuracy.

12   Frame stealing is typically one of two types: scheduled stealing or wild stealing.

13   For scheduled stealing, the system sends time information specifying when the mobile

14   station 16 is allowed to or requested to perform neighbor or MAHO list measurements;

15   the system stops sending data during that time frame. In contrast, wild stealing is when

16   the mobile system makes an autonomous decision to perform neighbor or MAHO list

17   measurements without providing any information to the cellular system. Arming the

18   cellular system with information relating to when the mobile station 16 is not available

19   for data reception and transmission improves system throughput. Frame stealing is

20   adaptable to either circuit-switched or packet-switched connections.

21   For circuit-switched connections, there is typically a minimum number of

22   measurements required for any given time period and for each entry in a measurement list

23   in order to maintain the quality of the channel quality measurement (CQM) report, if it is

1   addressed at all in the protocol/standard. Further, a maximum number of frames are

2   allowed to be stolen. This is done to maximize the time the mobile is allowed to make

3   specific measurements in order to put a limit on the reduction of data throughput. These

4   are conflicting requirements, which require efficient use of the mobile station 16 to

5   provide scheduled or wild stealing.

6   Both types of stealing are also applicable for packet-switched connections.

7   Further details regarding scheduled and wild frame stealing in packet-switched

8   connections is provided in U.S. patent entitled Apparatus and Method for Signal Strength

9   Measurement in a Wireless Communication System, which is incorporated herein by

10   reference.

11   Both GSM (GPRS) and ANSI-136 incorporate some or all of the aspects (i.e.

12   stealing) mentioned above in order to handle neighbor and MAHO list measurements in

13   active mode while in multi-slot operation. For a CDMA system, the availability of time

14   for neighbor and MAHO list measurements is typically not an issue as long as these

15   measurements are restricted to channels on the same frequency as the communication

16   channel.

17   The neighbor list and MAHO list may contain sub-lists for a defined area. That

18   is, the neighbor list or MAHO list may incorporate one or more area definitions defining

19   at least partially distinct areas. A sub-list would then be associated with eacharea

20   definition. Each sub-list may contain different neighbor and MAHO entries or one entry

21   may appear in several sub-lists. An example format of a list may be: area definition 1,

22   channel entries for area 1, attributes for cell 1; area definition 2, channel entries for Area

23   2, attributes for cell 2; ..., area M definition, channel entries for area M, attributes for cell

1   M. The attributes may include cell identity, service capability and the exact position of

2   the base station's transmitter for the given cell. U.S. patent number 5,353,332 relates to

3   providing information about other cells and is incorporated herein by reference.

4   Figures 3 and 4 show exemplary sub-division of cells into multiple areas. A

5   specified area, according to the information transmitted from the cellular system, may

6   overlap and cross the hypothetical cell areas defined as hexagons. Turning now to figure

7   3 in particular, omni-directional cells are assumed. For base station B1, there are three

8   areas. The first area is the area with radius R1, the second is the area within radius R2,

9   but not within the first area defined by R1. The third area is outside the circle defined by

10   radius R2. The base station B1 transmits information defining radius R1, radius R2, and

11   the position of its transmitter.

12   Base station B2 is configured differently and transmits coordinates in groups to

13   define areas. The first area is defined within coordinates P1, P2, P3, P4, P5 and P6. The

14   second area is defined within coordinates P5, P6 and P7. A third area is defined within

15   coordinates P5, P6, P7, P8 and P9. A fourth area is any position not covered by the other

16   three areas. Preferably, the base station B2 transmits the coordinates P1 through P9 and

17   the above area definitions to the mobile station 16.

18   Another configuration is shown associated with base station B3 where four areas

19   are defined. The first area is defined by radius R3. A second area is to the west (left) of

20   line L1, and a third area is defined by the area east (right) of L2. A fourth area is defined

21   by the remaining portions not covered by the three other areas.

22   Yet another exemplary configuration is shown associated with base station B4

23   where three areas are defined. The first area is east (right) of the line L3, and a second

1   area is west (left) of the line L3. A third area is defined by radius R4 from a particular

2   coordinate P1. Mobile stations 16 not subscribing to the system simply skip measuring

3   those entries. A configuration similar to that defined by B4 may also be of interest when

4   private systems are located within a cell. Thus, the channel entries for the area associated

5   with radius R4 may include one or more channels belonging to private systems. Base

6   station B4 may transmit the coordinates, line definitions and groupings, as do the other

7   base stations. Furthermore, for the area defined by radius R4, the identity and definitions

8   of private systems may be included with the channels to measure.

9   Figure 4 is exemplary of systems using sectorized cells. As depicted, each base

10   station has three sectors: S1, S2 and S3. For base station B5, one area is defined by the

11   coordinates P11, P12 and P13. Another area is defined with coordinates P11, P12 and

12   P10, the latter of which is the position of the base station. Yet another area is defined

13   west (left) of line L6 and north (above) line L5. Another area is defined east (right) of L6

14   and north (above) line L2, but not defined by the first two areas of coverage. Two

15   additional areas are defined using the remaining coordinates defined by the lines L5 and

16   L6. These coordinates, line definitions and the interpretations are transmitted by base

17   station B1.

18   As exemplified above, areas of interest may be defined in many different forms.

19   For example, a set of coordinates and hypothetically connected constituents in an area.

20   Another example is a distance from the position of a cell thereby defining areas as

21   concentric circles. The center position of the receptive cell may also be included as a

22   defined area.

1   In a preferred embodiment, once a mobile station 16 has determined its position it

2   may 1) measure all the entries associated with the area containing the mobile station 16

3   based upon its position; 2) measure other entries, such as areas neighboring the identified

4   area, with a lesser frequency; or 3) not measure some entries at all. The latter alternative

5   is preferably saved for non-adjacent areas. These decisions are preferably made in

6   association with information pertaining to cell configuration, such as defined by the areas

7   exemplified above. Importantly, any input or information from which position or

8   mobility may be derived is equally well suited for both active and idle modes of

9   operation.

10   The degree of measurement relaxation or change may depend on several factors

11   alone or in combination with one another. These factors include change in position

12   between position estimates; estimated speed, relative position of the mobile station 16 to

13   a serving cell and respective neighboring cells, or time spent in a current state. The latter

14   of which is preferably used while other inputs, such as position or speed are

15   approximately constant. Certain of these factors may be beyond any currently specified

16   protocol standards or rules of measurement, e.g. broadcasting area specific NL. This

17   information may be transmitted to the mobile station 16 using sub-lists and used in

18   association with specified measurement rules.

19   If mobility is determined, measurement procedures may be affected in numerous

20   ways. The most preferable of these would be to: 1) immediately revoke all measurement

21   relaxation; 2) gracefully revoke relaxation; 3) revoke measurement relaxation dependent

22   on the degree of mobility; or 4) revoke measurement relaxation dependent on the relative

23   position of the mobile station 16 to a current and/or respective neighboring cells. For

1   example, if the mobile station 16 is very close to the base station of the serving cell, it

2   will typically take a while for the mobile to reach a signal strength border and before a

3   geographic or more preferable the radio border reselection would take place. If the

4   mobile station 16 has the position of the neighboring base station, it can calculate the

5   time required with an assumed speed before it reaches the cell border. This time,

6   assuming a conservatively high speed, can be used to set the degree of measurement

7   relaxation and how quickly to react when mobility is detected.

8   As another example, assume the mobile station 16 is engaged in a packet data

9   session and is multi-slot capable, such as an eight-slot GPRS mobile station 16. As such,

10   the mobile station 16 must sometimes stop Rx or Tx or both data in order to fulfill a

11   required neighbor cell measurement procedure. This necessarily results in reduced data

12   rate throughput. However, for most instances of packet data operation resulting in a high

13   data transfer rate, the user is not traveling. For example, a user could download

14   information from the Internet while sitting in an airport, meeting room, hotel lobby or

15   office. The mobile station 16 may use position estimates over time to determine that it is

16   not moving. The likelihood that a channel change is required, which is the reason to

17   make these measurements in the first place, is relatively low. The longer the mobile

18   station 16 determines that it is not moving, the more likely that for the next period of time

19   there will not be any movement and channel selection measurements can be further

20   relaxed. Thus, the time the mobile station 16 stays in a current state or position may

21   affect the frequency of cell measurements. Based on the position or mobility within a

22   cell or an area within a cell, the mobile may change the frequency channel measurements

23   are made and, perhaps, the cells that are monitored.

1   It is worth noting that cell reselection may take place when a mobile station 16 is

2   well within the cell's geographic border because of signal propagation effects caused by

3   shadowing from buildings and hills. Furthermore, in a hierarchical cell structure, cell

4   reselection may take place between cells that transmit from the same position. To this

5   end, a safety margin is preferred when activating and deactivating the measurement

6   relaxation. The mobile station 16 may use measurements of neighboring cells to predict,

7   using relative signal strength, how close it is to a potential cell reselection or handover.

8   As noted, in circuit switched mode the cellular system typically determines which

9   cell or channel to use. The system may handoff a mobile station 16 because of load

10   sharing between base stations or sectors therein or the channel may be subject to severe

11   interference for which an intra-cell handoff may be advantageous. In principal, the

12   mobile should not second-guess the system. Thus, care should be taken when

13   determining how aggressively the measurement relaxation is implemented by the mobile

14   station 16 vendor while in circuit switched mode.

15   In idle mode the situation is more easily controlled since the only things that

16   affect cell reselection are the measurements made by the mobile station 16 and a few

17   static parameters sent over broadcast channels. Thus, in idle mode, the mobile can make

18   more reliable predictions. For example, the mobile station 16 may determine that if a

19   neighbor list entry is 10 dB stronger than the current channel, then it will make a cell

20   reselection. It is important to realize that the inputs described above, in addition to

21   affecting cell reselection, may also affect the frequency of making position estimates

22   during active and idle modes to the extent other applications provide.

1   Certain modifications and improvements will occur to those skilled in the art upon

2   a reading of the foregoing description. It should be understood that all such

3   modifications and improvements have been deleted herein for the sake of conciseness and

4   readability but are properly within the scope of the following claims.

5

CLAIMS

What is claimed is:

1.   A method of channel selection for a mobile station comprising:

determining a position of said mobile station;

periodically performing channel quality measurements of signals transmitted from

one or more base stations, wherein a frequency of performing said channel quality

measurements is a function of said position of said mobile station.

2.   The channel selection method of claim 1 wherein said frequency of performing

said channel quality measurements is a function of the relative position of said mobile

station with respect to a first base station serving said mobile station.

3.   The channel selection method of claim 1 wherein said frequency of performing

said channel quality measurements is a function of the relative position of said mobile

station with respect to a first base station serving said mobile station and at least one

additional base station.

4.   The channel selection method of claim 3 wherein said position of said at least one

additional base station is transmitted to said mobile station by said first base station.

5.   The channel selection method of claim 7 wherein said position of said at least one

additional base station is included in a neighbor list transmitted to said mobile station by

said first base station.

6. The channel selection method of claim 1 wherein said frequency of performing said channel quality measurements is a function of the mobility of said mobile station.

7. The channel selection method of claim 6 wherein said frequency of performing said channel quality measurements is a function of the rate of change of said position of said mobile station.

8. The channel selection method of claim 6 wherein said frequency of performing said channel quality measurements is a function of the length of time said mobile station remains in said position.

9. The channel selection method of claim 1 wherein said channel quality measurements are performed by said mobile station while said mobile station is in an idle mode.

10. The channel selection method of claim 1 wherein said channel quality measurements are performed by said mobile station while said mobile station is engaged in a packet switched call.

11. The channel selection method of claim 1 wherein said channel quality measurements are performed by said mobile station while said mobile station is engaged in a circuit switched call.

1

2   12.   The channel selection method of claim 1 wherein said mobile station uses said

3   channel quality measurement for cell reselection.

4

5   13.   The channel selection method of claim 1 further including transmitting said

6   channel quality measurements from said mobile station to a first base station serving said

7   mobile station.

8

9   14.   The channel selection method of claim 13 further including making hand-off

10   determinations at said first base station based on said channel quality measurements.

11

12

13   15.   A method of determining the position of a mobile station comprising:

14   determining a position of said mobile station at a first time instant; and

15   updating said position periodically, wherein a frequency of said updating is a

16   function of said position of said mobile station.

17

18   16.   The method of claim 15 wherein said frequency of updating said position is a

19   function of the relative position of said mobile station with respect to a first base station

20   serving said mobile station.

21

1   17.   The method of claim 15 wherein said frequency of updating said position is a

2   function of the relative position of said mobile station with respect to a first base station

3   serving said mobile station and at least one of said additional base station.

4

5   18.   The channel selection method of claim 17 wherein the position of said at least one

6   additional base station is transmitted to said mobile station by said first base station.

7

8   19.   The method of claim 18 wherein said position of said at least one additional base

9   station is included in a neighbor list transmitted to said mobile station by said first base

10 station.

11

12 20.   The method of claim 15 wherein said frequency of updating said position is a

13 function of the mobility of said mobile station.

14

15 21.   The method of claim 20 wherein said frequency of updating said position is a

16 function the rate of change of said position of said mobile station.

17

18 22.   The channel selection method of claim 20 wherein said frequency of updating

19 said position is a function of the length of time said mobile station remains in said

20 position.

21

22 23.   The method of claim 15 wherein said updating is performed by said mobile

23 station while said mobile station is in an idle mode.

1

2　24.　The method of claim 15 wherein said updating is performed by said mobile

3　station while said mobile station is engaged in a packet switched call.

4

5　25.　The method of claim 15 wherein said updating is performed by said mobile

6　station while said mobile station is engaged in a circuit switched call.

7

8　26.　The method of claim 15 further including transmitting position information from

9　said mobile station to said base station.

10

11

12　27.　A method for channel selection by a mobile station comprising:

13　　　　serving said mobile station with a first base station;

14　　　　generating a list of neighboring base stations and corresponding positions for each

15　　　　　　said neighboring base stations; and

16　　　　transmitting said at least one list of neighboring base stations and corresponding

17　　　　　　positions for each of said neighboring base stations to said mobile station.

18

19　28.　The method of claim 27 wherein said step of transmitting said list of neighboring

20　base stations and corresponding positions for each of the neighboring base stations is

21　transmitted on a broadcast channel.

22

1 29.   The method of claim 27 wherein said step of transmitting said list of neighboring

2 base stations and corresponding positions for each of the neighboring base stations is

3 transmitted on a point-to-point channel.

4

5 30.   The method of claim 27 including wherein said list includes a plurality of area

6 definitions, and wherein said neighboring base stations in said list are associated with at

7 least one of said area definitions in said list.

8

9 31.   A mobile station comprising:

10   a transceiver transmitting and receiving radio frequency signals;

11   a signal processor operatively connected to said transceiver, said signal processor

12   periodically performing channel quality measurements on selected signals

13   received by said transceiver;

14   control logic controlling said signal processor and said transceiver to vary the

15   frequency of performing said channel quality measurements as a function of

16   the position of said mobile station.

17

18 32.   The mobile station of claim 31 wherein said control logic varies the frequency of

19 performing said channel quality measurements based on the relative position of said

20 mobile station with respect to a first base station serving said mobile station.

21

22 33.   The mobile station of claim 31 wherein said control logic varies the frequency of

23 performing said channel quality measurements based on the relative position of said

1   mobile station with respect to a first base station serving said mobile station and at least

2   one additional base station.

3

4   34.   The mobile station of claim 31 wherein said control logic varies the frequency of

5   performing said channel quality measurements based on the mobility of said mobile

6   station.

7

8   35.   The mobile station of claim 34 wherein said control logic varies the frequency of

9   performing said channel quality measurements based on the rate of change of said

10   position of said mobile station.

11

12   36.   The mobile station of claim 34 wherein said control logic varies the frequency of

13   performing said channel quality measurements based on the length of time said mobile

14   station remains in said position.

15

16   37.   The mobile station of claim 31 further including a positioning receiver for

17   determining the position of said mobile station.

18

19   38.   A mobile station comprising:

20   a transceiver transmitting and receiving radio frequency signals;

21   a positioning receiver periodically determining a position of said mobile station;

1   control logic controlling said transceiver and said positioning receiver, wherein

2   said control logic varies the frequency of determining said position of said

3   mobile station as a function of said position.

4   39.   The mobile station of claim 38 wherein said control logic varies the frequency of

5   determining said position of said mobile station based on the relative position of said

6   mobile station with respect to a first base station serving said mobile station.

7

8   40.   The mobile station of claim 38 wherein said control logic varies the frequency of

9   determining said position of said mobile station based on the relative position of said

10   mobile station with respect to a first base station serving said mobile station and at least

11   one additional base station.

12

13   41.   The mobile station of claim 38 wherein said control logic varies the frequency of

14   determining said position of said mobile station based on the mobility of said mobile

15   station.

16

17   42.   The mobile station of claim 38 wherein said control logic varies the frequency of

18   determining said position of said mobile station based on the rate of change of said

19   position of said mobile station.

20

21   43.   The mobile station of claim 38 wherein said control logic varies the frequency of

22   determining said position of said mobile station based on the length of time said mobile

23   station remains in said position.

1

44.   A method of controlling a mobile station comprising:

       determining a position of said mobile station; and

       performing a periodic task, wherein a frequency of performing said task is a

function of said position of said mobile station.

6

45.   The control method of claim 44 wherein said frequency of performing said

periodic task is a function of the relative position of said mobile station with respect to a

first base station serving said mobile station.

10

46.   The control method of claim 44 wherein said frequency of performing said

periodic task is a function of the relative position of said mobile station with respect to a

first base station serving said mobile station and at least one additional base station.

14

47.   The control method of claim 44 wherein said frequency of performing said

periodic task is a function of the mobility of said mobile station.

17

48.   The control method of claim 47 wherein said frequency of performing said

periodic task is a function the rate of change of said position of said mobile station.

20

49.   The control method of claim 47 wherein said frequency of performing said

channel quality measurements is a function of the length of time said mobile station

remains in said position.

1

2   ABSTRACT OF THE DISCLOSURE

3   The present invention relates to a mobile station capable of determining its current

4   location within a wireless communication system. The mobile station periodically

5   generates an estimate of its current location or mobility and then monitors channels for

6   channel selection based thereon in order to minimize frame stealing while in active mode

7   and save energy during idle mode. The same information is also useful for determining

8   which cells to monitor and controlling how frequently position or changes of position

9   estimates are made. Although the invention requires a determination of the mobile

10   station's position or mobility, the manner in which the mobile station determines these

11   characteristics may vary. A separate positioning receiver, terrestrial or satellite based,

12   such as that used with the Global Positioning System, may allow the mobile station to

13   calculate its position. Alternatively, the mobile station may monitor signals provided

14   during communications with the base stations to calculate a relative position. In yet

15   another embodiment, the base stations and associated cellular systems may cooperate to

16   determine a particular mobile station's position and then download the position to the
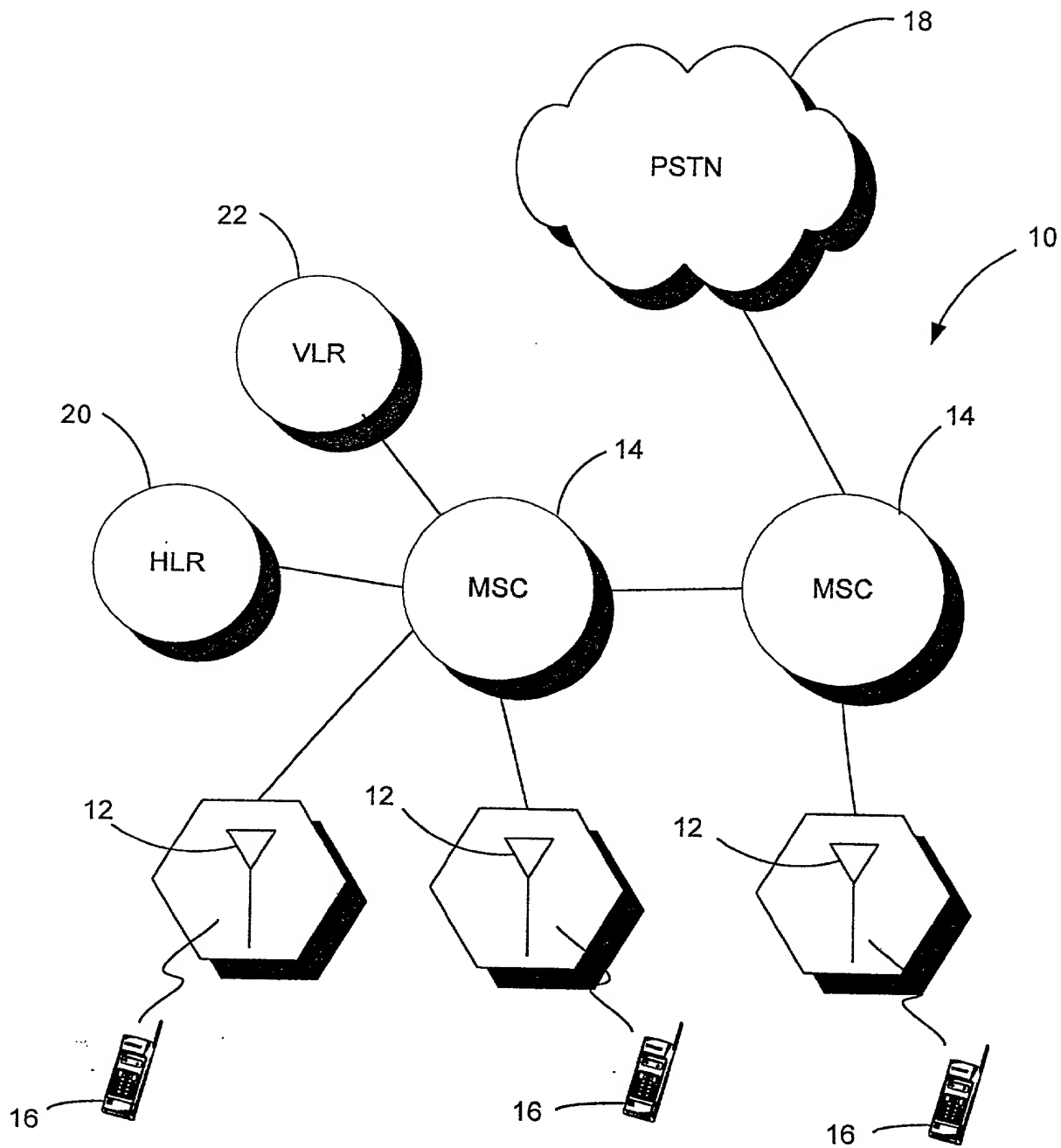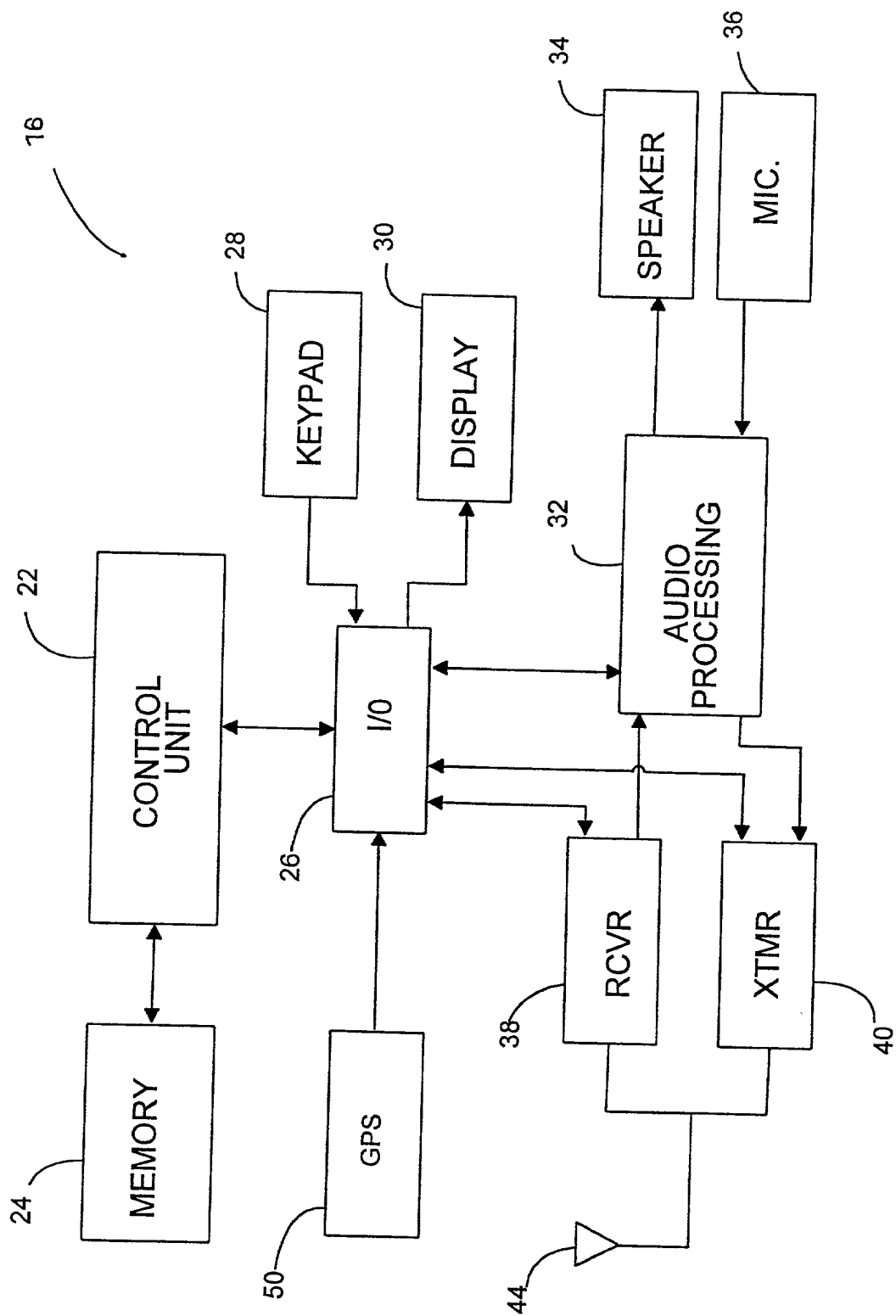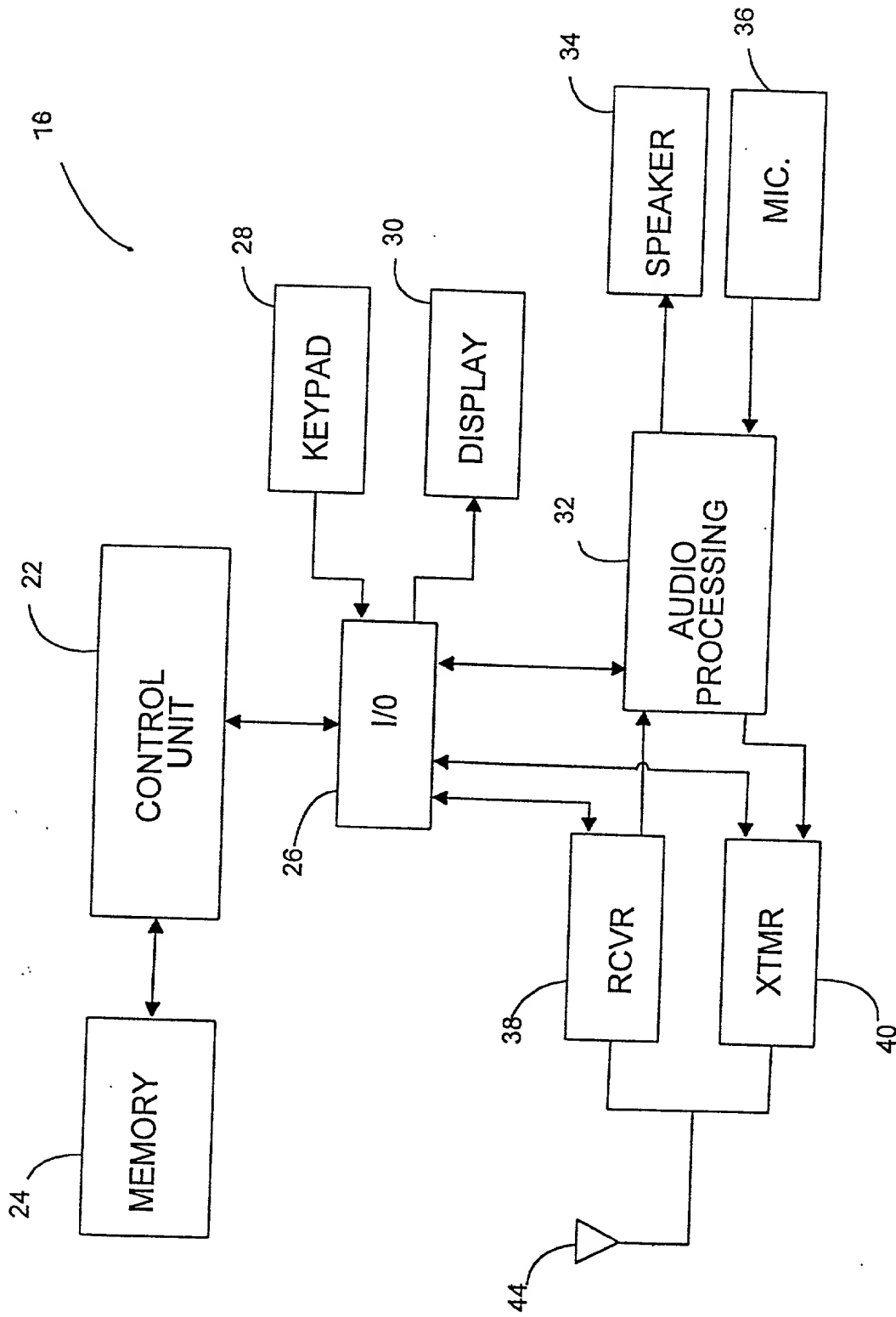
17   mobile station.

FIG. 1

16

MEMORY 24

CONTROL UNIT 22

KEYPAD 28

DISPLAY 30

I/O 26

GPS 50

AUDIO PROCESSING 32

SPEAKER 34

MIC. 36

RCVR 38

XTMR 40

44

FIG. 2A

FIG. 2B

FIG. 3

FIG. 4

ACTIVE MODE   IDLE MODE

START ─ 100

INITIATE CALL OR
HANDOFF ─ 102

                                              YES

                          RECEIVE OR SET-
                          UP NEW CALL? ─ 116

MS RECEIVES
NEIGHBOR (OR MAHO)
LIST ─ 104

                                              NO

MS DETERMINES
POSITION AND/OR
MOBILITY ─ 106

                          MS DOWNLOADS
                          NEIGHBOR LIST FROM
                          BASE STATION(S) ─ 120

                          MS DETERMINES
                          POSITION OR MOBILITY ─ 122

MS MONITORS
CHANNELS ON LIST
DEPENDING ON
POSITION OR MOBILITY ─ 108

                          MS MONITORS
                          CHANNELS ON LIST
                          DEPENDING ON
                          POSITION OR MOBILITY ─ 124

MS MONITORS BASE
STATION FOR
HANDOFF
INSTRUCTION ─ 110

                          MS DETERMINES IF
                          CELL-RESELECTION IS
                          NECESSARY ─ 126

END
CALL? ─ 112   YES

NO

NO   HANDOFF ? ─ 114

YES
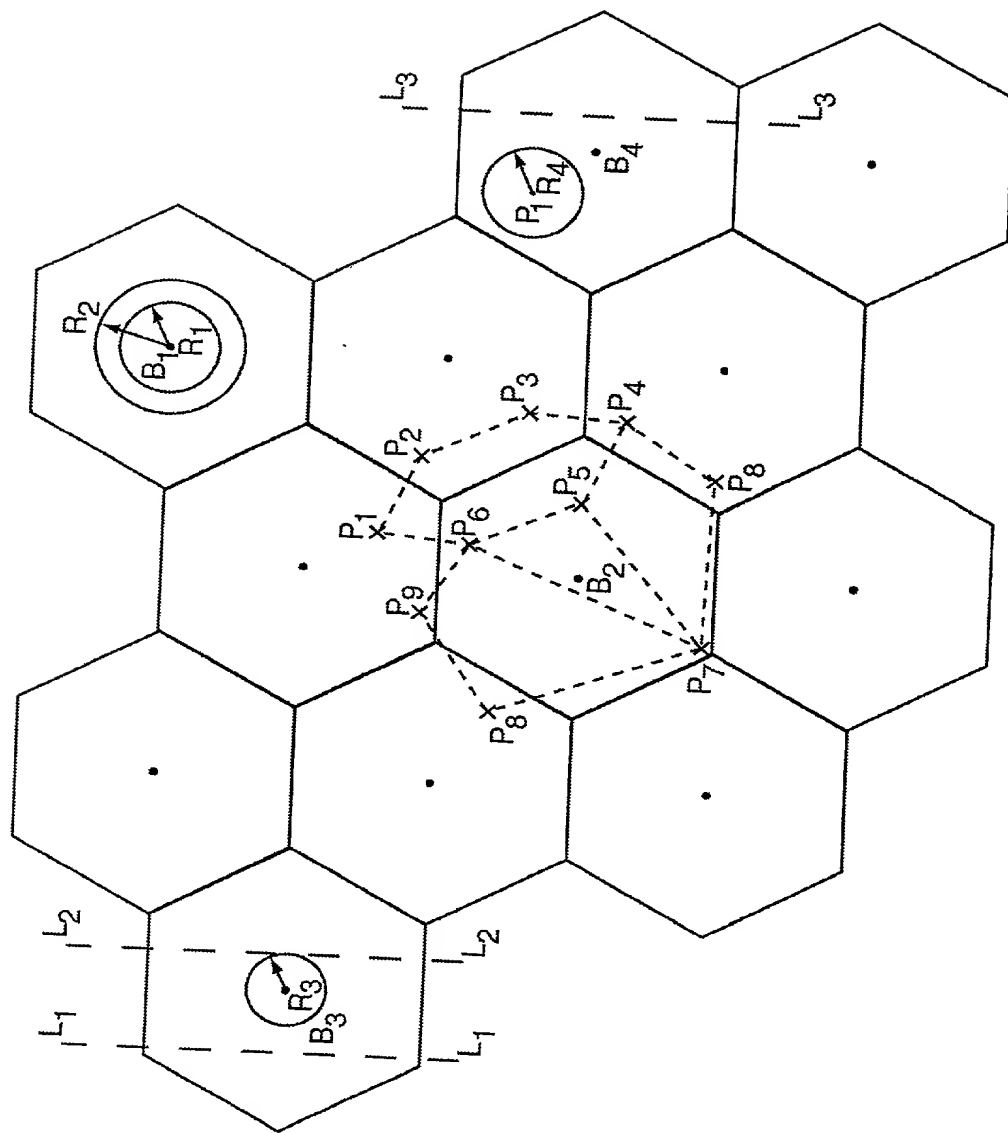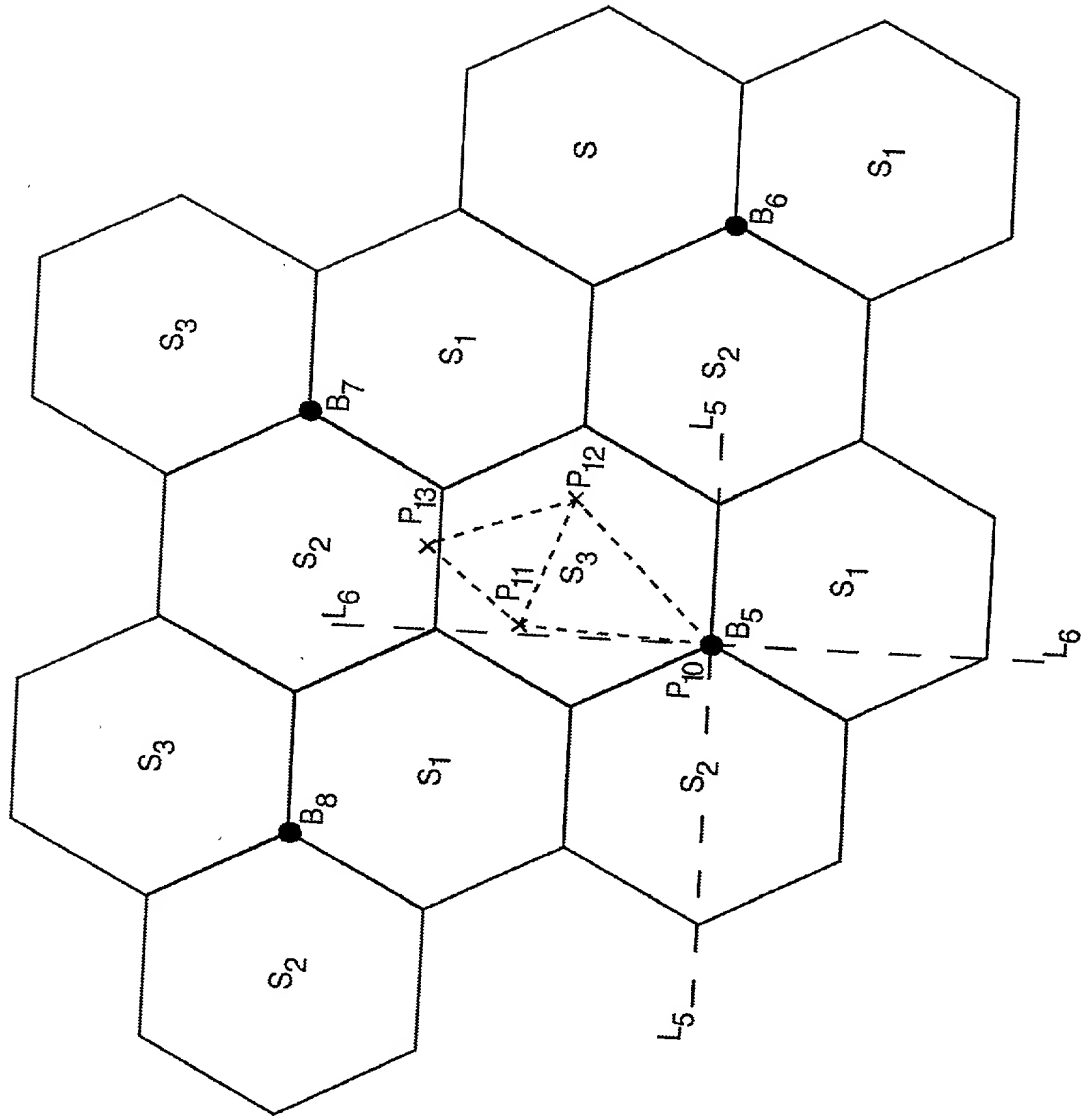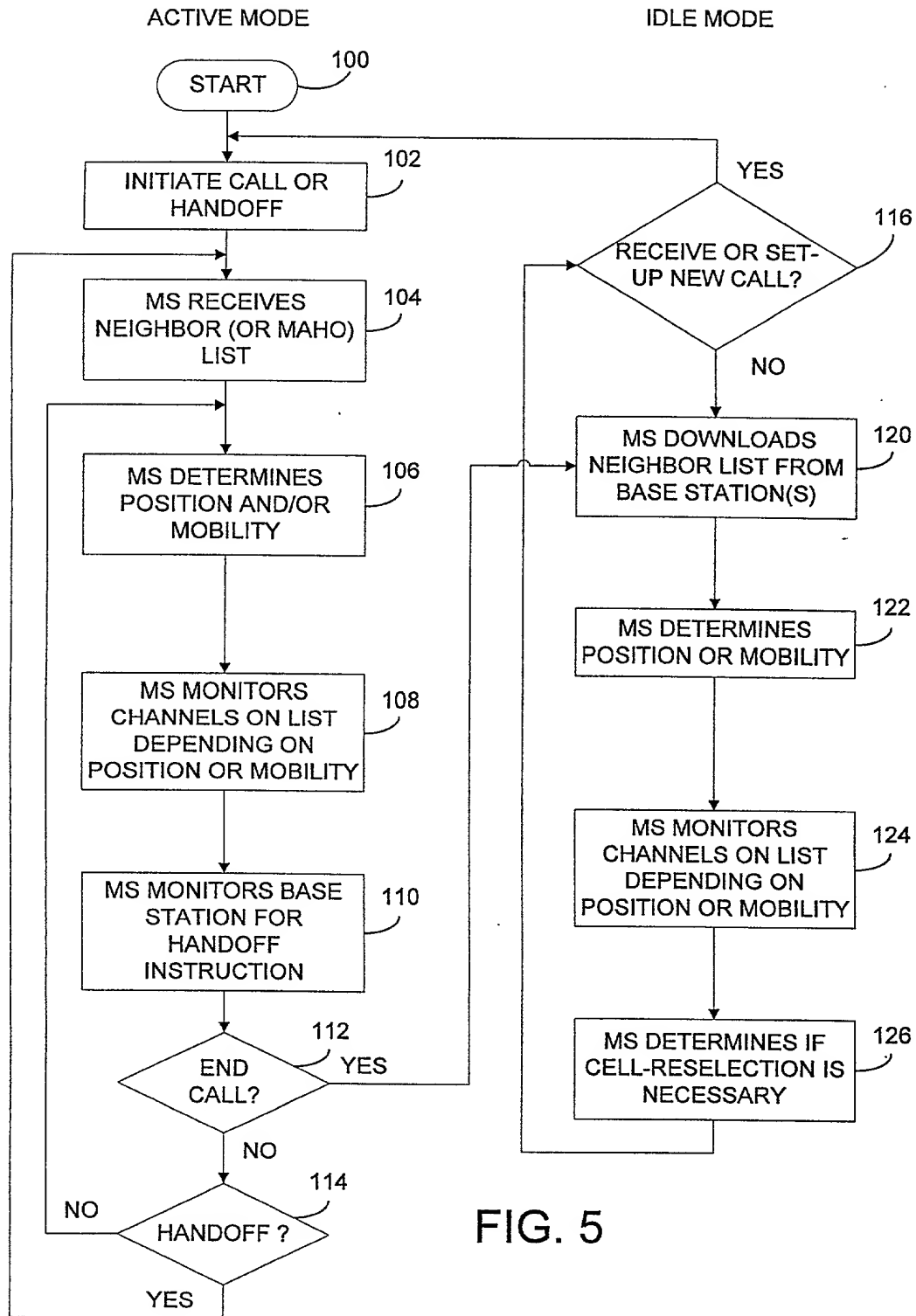
FIG. 5

Declaration and Power of Attorney for Patent Application

As below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe that I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled **SYSTEM AND METHOD FOR IMPROVING CHANNEL MONITORING IN A CELLLULAR SYSTEM**, the specification of which

[X]   is attached hereto.

(Check one)

[ ]   was filed on   _____ as
        Application Serial Number   _____
        and was amended on   _____ .
                                                    (if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me which is material to patentability (as defined in C.F.R. §1.56) in connection with the examination of this application.

I hereby claim foreign benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)   **Priority Claimed**

NONE_____ _____ _____ [   ]   [   ]
(Number)   (Country)   (Day/Month/Year Filed) YES   NO

_____ _____ _____ [   ]   [   ]
(Number)   (Country)   (Day/Month/Year Filed) YES   NO

_____ _____ _____ [   ]   [   ]
(Number)   (Country)   (Day/Month/Year Filed) YES   NO

Declaration and Power of Attorney for Patent Application

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

NONE
_____   _____   _____
(Application Serial No.)   (Filing Date)   (Status: Patented/Pending/Abandoned)

_____   _____   _____
(Application Serial No.)   (Filing Date)   (Status: Patented/Pending/Abandoned)

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Declaration and Power of Attorney for Patent Application

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

SOLE OR FIRST INVENTOR:

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